Medical Informatics at the University of Utah: Applying Research to Real-Life Issues

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The University of Utah has a Master's and Doctorate (Ph.D.) program designed to train investigators and practitioners in applied medical informatics. In other words, our students and graduates learn to apply the science of medical informatics to the real healthcare problems faced by clinicians, administrators, and informaticians. Our faculty, students, and graduates work in the areas of clinical decision support, medical vocabulary, genetics, clinical data repositories, and medical imaging. They develop and apply electronic medical records while they also evaluate these systems in order to determine their cost-effectiveness in actual care delivery systems. Both the Master of Science and Doctorate degrees are research in nature: Students are required to perform a research project, defend that project to a faculty committee, and submit a thesis for the Master of Science degree and a dissertation for the Ph.D. degree.

Three primary training and research sites are available at the University of Utah, providing a diverse set of opportunities. The sites are: The University of Utah Health Sciences Center (UUHSC); Intermountain Health Care (IHC), which includes LDS (Latter Day Saints) Hospital and other inpatient and outpatient facilities; and the national Veterans Affairs facilities associated with the local VA Medical Center. In addition, the University of Utah and other facilities maintain important working relationships with the healthcare computing industry in the Salt Lake City area.

In 1995, in anticipation of the continued development of the Department of Medical Informatics training at Utah with its historically broad and multisited training program, the faculty, students, and alumni created numerous changes to the existing curriculum. Five tracks for training students in informatics were developed: (1) health informatics, (2) medical expert systems, (3) quality improvement informatics, (4) genetic epidemiology, and (5) medical imaging. Based on the previous experience of the university, its faculty, and its students, tracks 1, 2, and 3 were expected to be the major source of research effort. Indeed, the past four years have affirmed that research efforts in these three areas have been the most productive.

For each Fall and Winter term, an admissions committee of the Department of Medical Informatics selects approximately 15 graduate students to enter the program. Since 1996, our admitting classes have included between 10 and 12 physicians and three to five predoctoral students. In earlier years the department typically admitted between eight and 10 students per year and only two or three physicians. Currently, most physicians admitted to the program have completed specialty training at the level of being board certified to being fellowship trained, including a small number of faculty members at other universities. The predoctoral students come from a variety of professional backgrounds, but the majority are from the physical sciences: physics, engineering, and computer science. In addition, several from life sciences such as biology and genetics are admitted.

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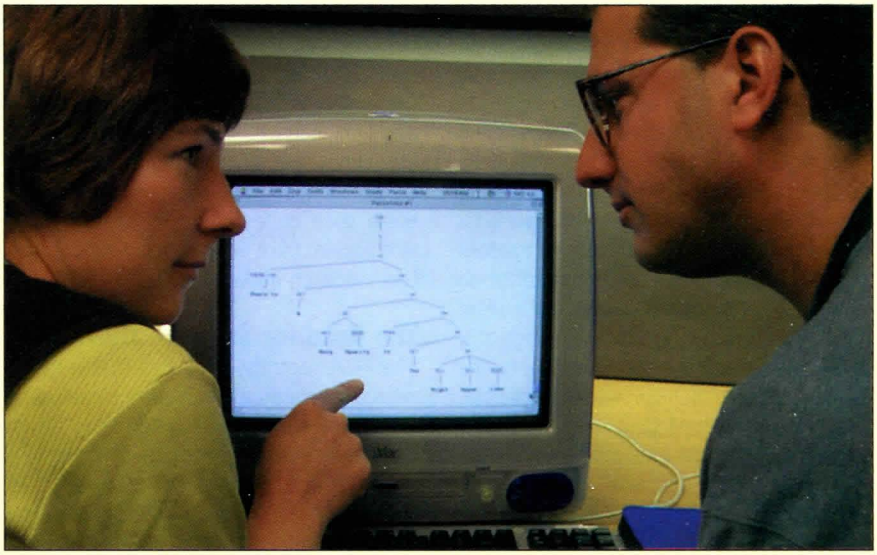
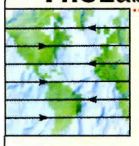
Developing an Infrastructure

LDS Hospital and IHC. Research projects at LDS Hospital and the Urban Central Region of IHC (the four Salt Lake Valley Hospitals—LDS Hospital, Primary Children's Medical Center, Cottonwood Hospital, and Alta View Hospital) are primarily related to the use of the HELP (Health Evaluation through Logical Processing) clinical information system. Medical informatics faculty members located at LDS Hospital include Peter J. Haug, M.D.; R. Scott Evans, Ph.D.; Thomas D. East, Ph.D.; and Reed M. Gardner, Ph.D.

The corporate information systems component of Intermountain Health Care has responsibility for computer system planning and development for IHC's 23 hospitals and a growing number of outpatient clinics. This active and important medical informatics group is supervised by faculty members T. Allan Pryor, Ph.D., and Stanley M. Huff, M.D. In addition, several senior informatics fellows work at the IHC central office, the Urban South



Wendy Chapman (left) and Marcelo Fiszman, M.D., both Ph.D. candidates in medical informatics, discuss the parsed results of their work in "natural language processing." Future use of natural language processing techniques will have high utility in the development of enterprise clinical information systems.



Region in Provo, and the Urban North Region in Ogden. These groups are working to establish an enterprisewide health information infrastructure that will include development of an outcomes database to assist in outcomes research and quality improvement studies, the HELP system, and a Longitudinal Data Repository with associated standardized vocabulary system, as well as development of a clinical workstation and an outpatient records system.

The HELP clinical information system has been developed and evaluated at LDS Hospital. At the same time, computerized decision support tools have been developed, including protocols for diagnosis and treatment of pneumonia, minimization of adverse drug events, and optimization of the timing of antibiotics administration to at-risk surgical patients. In addition, a computerized "antibiotic assistant" has been very successful in providing tools for optimum antibiotic selection. When research projects have been evaluated for effectiveness in the clinical care setting, the findings have often proved to be positive and exciting.

The use of computers in Intensive Care Units (ICUs) has provided a rich resource for research projects. These projects include protocol development, nurse charting advancements, and acquisition of data from monitoring devices. The development of the Institute of Electrical and Electronics Engineers (IEEE 1073) Medical Information Bus (MIB) standard was one of the pioneering efforts carried out in the ICUs at LDS Hospital. Determining what data to collect from the monitoring devices, as well as how often and how to use it, is still very much a work-in-progress. Like the ICU, the entire modern hospital will soon have bedside monitoring devices. Using these devices to collect data that is representative and timely still presents a challenge. In addition to the typical bedside monitor with heart rate, ECG rhythm, blood pressure, and pulse oximetry, these devices also monitor IV drip rate charting, ventilator settings, urine output, and the recent addition of bedside chemistry data acquisition.

Much of medicine is still recorded as voice dictation. Voice recognition technology will provide a faster, more efficient way of translating the voice signal into a computerized format. Current research aims to optimize data acquisition using this technology. Related investigations into the error rate, smart data correction, and improvement of turnaround time are underway. While generating free text data from dictation is essential, however, it is still important to use natural language processing to obtain coded data for the HELP and other information systems used for decision making. For example, the transcribed chest x-ray findings are now processed to determine whether there is evidence of pneumonia in the dictated report: a crucial piece of clinical information. Future use of natural language processing techniques will have high utility in the development of enterprise clinical information systems.

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Computerized labor and delivery data acquisition and charting is now operational at nine IHC hospital sites. The initial research and development was conducted by a graduate student at LDS Hospital. This rich data source is now being used to optimize care during the delivery process. Computer records for over 100,000 deliveries are already on file in the database. Online computerized decision support is being used to apply guidelines for appropriate use of Caesarean section deliveries. Evaluation of these data collections, decision support, and patient care processes provides excellent research opportunities.

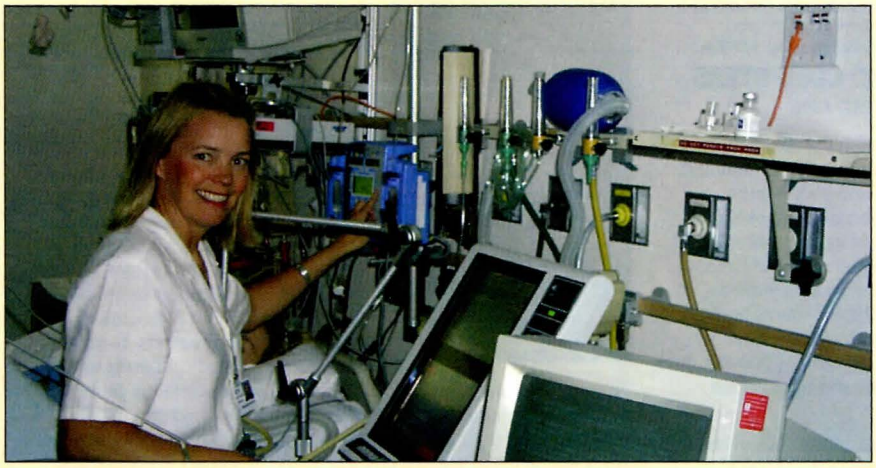
The Need for Software Oversight

The FDA recently suggested that it might regulate medical software, including enterprise information systems. To assess the need for and practicality of such oversight, research was initiated at LDS Hospital; the University of Utah Medical Center; Vanderbilt University Medical Center; and Brigham and Women's Hospital. Software Oversight Committees (SOC) have been formed at each institution and have investigated a wide variety of issues, including system reliability, acquisition and testing of medical software, and methods of assessing the magnitude and importance of system failures. Each site has also developed research methodologies to improve the processes of medical software selection, software installation, and software and hardware maintenance, as well as system integration through system interfaces. The resulting findings have already helped the four participating institutions improve processes and interfaces. Future prospects for system improvement using the methodologies being developed are promising.

A final challenge at IHC is to migrate from the HELP system to a more modern hardware and software platform. The transition is made all the more difficult by the rich capabilities of applications running on the HELP system. Because such a transition is not unique to the group in Salt Lake City, we can learn by doing research on system transition strategies; the next time migration of this sort becomes necessary, these strategies should make the process more attractive and perhaps more frequent.

Health Sciences Center at the University of Utah. The University Hospital and affiliated clinics are currently installing an OASIS (Outcome and Assessment Information Set) inpatient clinical information system. The purchase and installation are under the direction of Pierre S. Pincetl, M.D., chief information officer at the University Health Sciences facility and a member of the medical informatics faculty. The selection of a commercially available system at the university has allowed both faculty and students to observe firsthand the issues of specifying, selecting, and installing a system from a commercial vendor. Indeed, the selection of a vendor and implementation of the system specifically provided excellent research opportunities for several students and faculty members and justifies a complete research review of its own.

Two other major clinical healthcare systems affiliated with the medical informatics training program have either chosen or implemented systemwide computer systems (VA Medical Centers) or used internally developed computer systems (LDS Hospital and Intermountain Health Care). Students in the program therefore



Nancy Nelson, R.N. and M.S. candidate, adjusts an IV pump connected to a Medical Information Bus. In the foreground is a bedside computer terminal and ventilator. Above her head is the typical ICU bedside monitor for measuring ECG and blood pressure. Like the ICU, the entire hospital will soon have beside monitoring devices.

have the opportunity to observe and learn from three quite separate and different strategies and implementation plans.

Bruce E. Bray, M.D., has worked at applying Internet tools in the healthcare environment for both hospitalized patients and potential patients, developing knowledge representation models and structured vocabulary for clinical medicine, developing medical expert systems for computerized practice guidelines, and improving the interfaces for clinical information systems.

Dean K. Sorenson, Ph.D., has specialized in conducting knowledge engineering sessions with experts in medical subspecialties for enhancement of the Iliad diagnostic expert system. He has also supervised students in the development of a variety of databases for use by preventive cardiology, short stay surgery, labor and delivery, and postpartum care. His expertise and experience with web technology is a valuable resource to medical informatics students.

Genetic Research

Health Care Genetic Research at University of Utah and IHC. The Genetic Research Group, which includes faculty members Lisa Cannon-Albright, Ph.D., and Susan L. Neuhausen, Ph.D., focuses primarily on the identification of disease susceptibility genes by studying high risk families. Recently, the group identified the first two known breast cancer genes. In addition, the group has 30 years of experience in working with the State of Utah Cancer Register and has linked that database with population databases. This unique combination of computerized databases enables study of clustering of cancer in a population and the identification of families with high risk for cancer at various body sites. The IHC segment of the group is currently using data from the LDS Hospital and other IHC HELP systems (the largest single clinical database in Utah) to provide links to publicly available genealogical records in order to study other inherited traits such as asthma and high blood pressure.

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Medical Imaging Research Laboratories at the University of Utah and LDS Hospital. The imaging laboratories available at both the University of Utah and LDS Hospital are available to students. These laboratories have several sophisticated high-end image processing systems that use magnetic resonance angiography to reconstruct coronary and cerebral arteries. Dennis L. Parker, Ph.D., has a very strong background in medical imaging and is currently working with his students on new technologies for improving the information content of existing radiology techniques. His research centers on magnetic resonance angiography, techniques to maximize imaging efficiency, 3D reconstruction of coronary arteries using digital subtraction angiography, and cardiac imaging that uses noninvasive magnetic resonance imaging (MRI).

Veterans Administration Medical Center. The Salt Lake City VA Medical Center has several VA medical informatics research fellows supervised by Michael J. Lincoln, M.D. Dr. Lincoln conducts research into the development of vocabulary of electronic medical records, the development of graphical user interfaces for clinicians, and the implementation of medical curricula for medical students at the university. He teaches special courses for all new medical students and works with medical students from all four years of the medical school curricula.

Charlene R. Weir, Ph.D., is primarily interested in modeling of clinicians' referral decisions that can be supported by computerized medical decisionmaking. She is also an expert in the field of evaluation and provides a rich resource for student evaluation projects in a wide variety of medical informatics projects.

Conclusion

The diversity of the faculty involved at each of the sites mentioned is a major strength of the Department of Medical Informatics at the University of Utah. In addition, several adjunct faculty are involved as consultants in medical informatics. Private companies that do medical informatics research add varied, pragmatic operational exposure to operational informatics for our students. A more complete and continually updated review of the University of Utah Department of Medical Informatics can be found at its web site: www.med.utah.edu/medinfo. ●

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